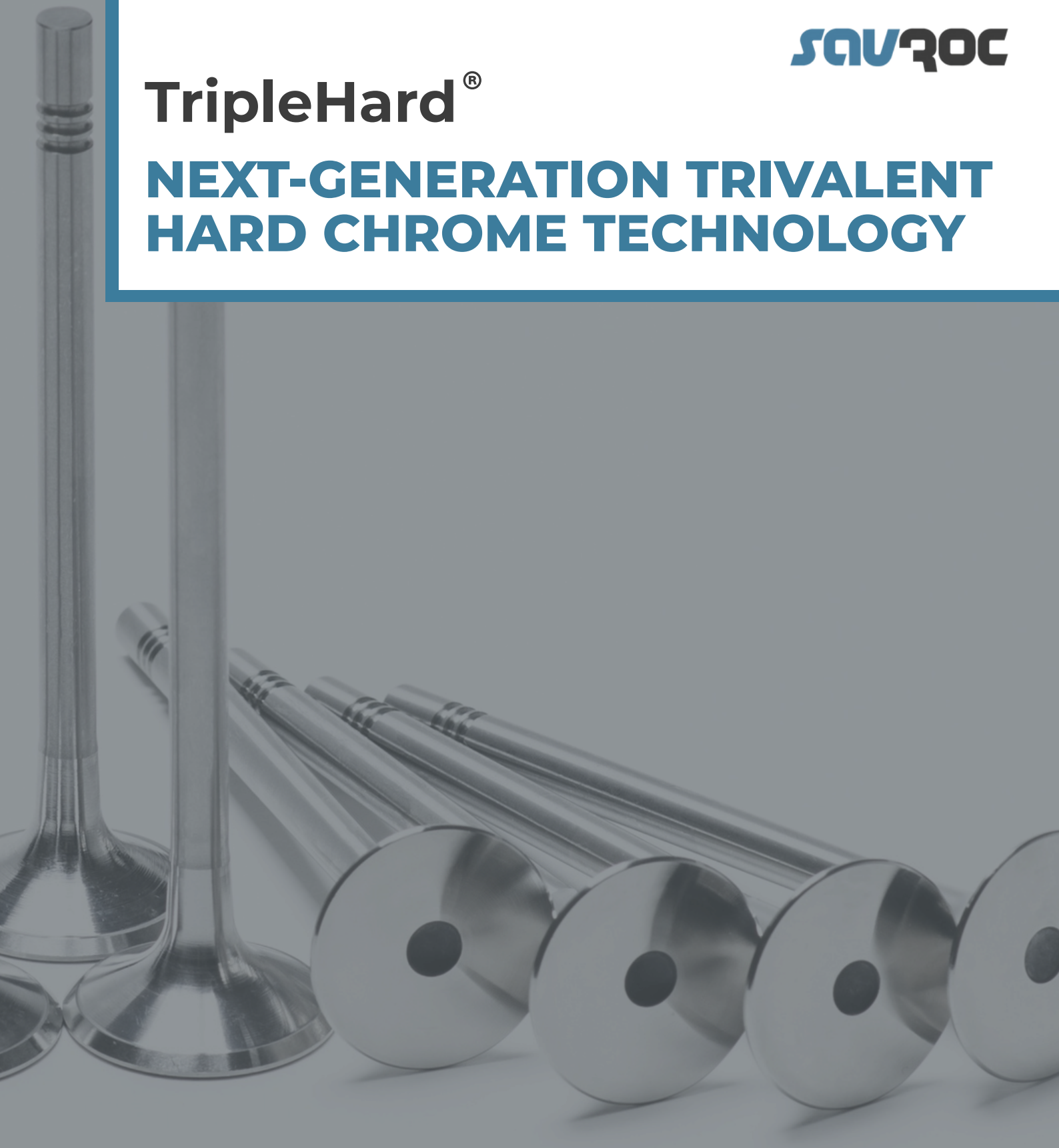
SAVROC

TripleHard®

NEXT-GENERATION TRIVALENT HARD CHROME TECHNOLOGY



NEXT-GEN PERFORMANCE FOR ENGINE COMPONENTS

For over a decade, Savroc has developed advanced trivalent chromium coatings to meet the growing demand for safer and more sustainable surface technologies. TripleHard® is the latest result of this development — a high-performance trivalent hard chrome coating for engine valves in demanding environments.

Combining hardness, wear resistance, corrosion and heat protection with a smooth, uniform surface, TripleHard® delivers the proven durability of hard chrome without the environmental and safety concerns of hexavalent chromium.

Built for the harshest engine conditions

Engine valves operate in extreme conditions – high temperatures, continuous impact on the valve seat, and abrasive gas flows. TripleHard® has been developed to protect valve surfaces against wear, corrosion, and microcracking under these severe loads.

The coating's structure and hardness remain stable even at elevated temperatures, ensuring long-lasting protection and consistent performance for intake and exhaust valves. The result: reduced wear in the valve guide, fewer maintenance interventions, and more reliable engine operation across thermal cycles.

Sustainable surface technology

Savroc's long-term goal is to make this trivalent technology the industrial standard for engine valve coatings and other demanding engine components — matching or surpassing hard-chrome performance while advancing a more sustainable future for heavy equipment manufacturing.

TripleHard® is entirely free from hexavalent chromium and fully compliant with REACH and current environmental directives. Beyond compliance, it enables substitution of a known carcinogenic process with a safer, proven alternative — exactly what regulators expect when viable options exist.

Conventional hard chrome imposes heavy EHS burdens: toxic-mist control, exposure monitoring, hazardous-waste handling and permitting. TripleHard's trivalent nickel-chrome system reduces worker exposure, simplifies ventilation and waste management, and de-risks audits — without compromising component performance.

Engineered precision in every layer

TripleHard® combines the well-known hardness and mirror-like finish of traditional hard chrome with the uniformity and control of a modern trivalent chromium process. The coating is applied using optimized plating parameters that balance current density, temperature and bath chemistry to achieve a dense, fine-grained microstructure.

Each layer is deposited and finished under tightly monitored conditions to ensure excellent adhesion to the base steel, low surface roughness and a defect-free coating. The process allows precise control of coating thickness and guarantees that every valve can be ground, polished and integrated into assemblies just like conventionally coated components.

Consistent quality, proven results

Savroc's production follows standardized quality procedures designed for industrial scalability. Every coating batch is inspected for hardness, thickness uniformity, adhesion and corrosion resistance according to ISO 9227, ISO 4287 and ASTM G65 test methods.

These systematic controls ensure repeatable performance from sample batches to full production lines. The coating has been validated in demanding engine applications, confirming stable friction behavior, long wear rates and excellent resistance to surface pitting and corrosion. Partners can rely on consistent surface quality and predictable performance through the entire lifecycle of the component.

TRIPLEHARD

Trivalent Hard Chrome Coating for Engine Valves

TripleHard® coating is designed for use on common engine valve steels. These materials provide the required combination of high-temperature strength, fatigue resistance and toughness, while the trivalent nickel–chrome coating ensures excellent surface properties and long-term resistance to wear and corrosion.

The coating process is compatible with standard valve manufacturing and finishing operations, including grinding, lapping and polishing, and can be integrated into existing production equipment with targeted adjustments.

Typical applications & base materials

TripleHard® coated valves are suited for a wide range of engine applications, including:

- Intake and exhaust valves in heavy-duty diesel and gas engines
- Valves in off-highway, marine and industrial engines
- Other reciprocating engine components where a hard, low-friction surface is needed

The coating can be applied to typical heat-resistant valve steels, with proper pre-treatment, also to stainless and alloyed valve grades.

Corrosion testing (NSS - ISO 9227)

TripleHard® coatings have been tested in Neutral Salt Spray (NSS) conditions at 35 °C according to ISO 9227 and evaluated per ISO 10289. All samples maintained full protection (rating 10) throughout the test durations listed below.

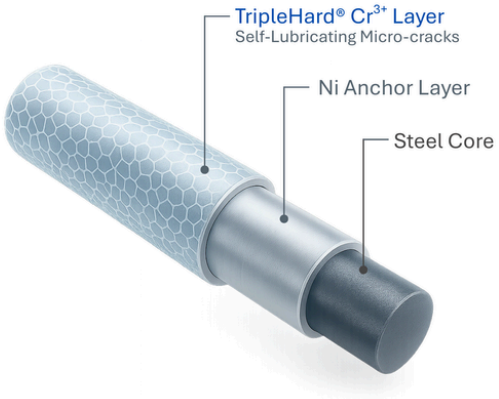
In addition, abrasive wear and scratch tests have confirmed the high hardness and toughness of the coating, supporting its use on valve stems and seating areas in demanding engine conditions.

Performance summary

Test condition	Coating thickness	Surface hardness ($HV_{0.05}$)	Surface roughness (Ra)
200 h NSS - TripleHard®	30 µm	1,000 - 1,300 HV	< 0.2 µm
500 h NSS - TripleHard®	40 µm	1,000 - 1,300 HV	< 0.2 µm
1000 h NSS - TripleHard®	50 µm	1,000 - 1,300 HV	< 0.2 µm

Coating composition

TripleHard® surface consists of a dual-layer system combining nickel and trivalent chromium. The nickel underlayer enhances corrosion protection and adhesion, while the trivalent chromium top layer provides surface hardness, wear resistance and the bright metallic appearance expected from high-quality engine components.



Manufacturing & finishing compatibility

TripleHard® is built for existing engine valve production. The duplex nickel–trivalent chrome process integrates into current plating lines with targeted changes to bath chemistry and process control, and converting a Cr(VI) line to TripleHard® is less costly than upgrading it to meet new Cr(VI) restrictions.

After coating, valves follow the same finishing steps – grinding, lapping and polishing on existing equipment. The uniform coating maintains tight stem and seat tolerances and withstands re-grinding in service.

DURABILITY IN EXTREME ENGINE CONDITIONS

Engine valves operate in an extremely demanding environment – continuous heat, friction, impact loads and corrosive combustion gases. TripleHard® is designed to protect valve surfaces in exactly these conditions, and lab and field tests show clearly better wear, heat and corrosion resistance than conventional hard chrome, without the Cr(VI) health and environmental concerns.

Wear resistance and reduced friction

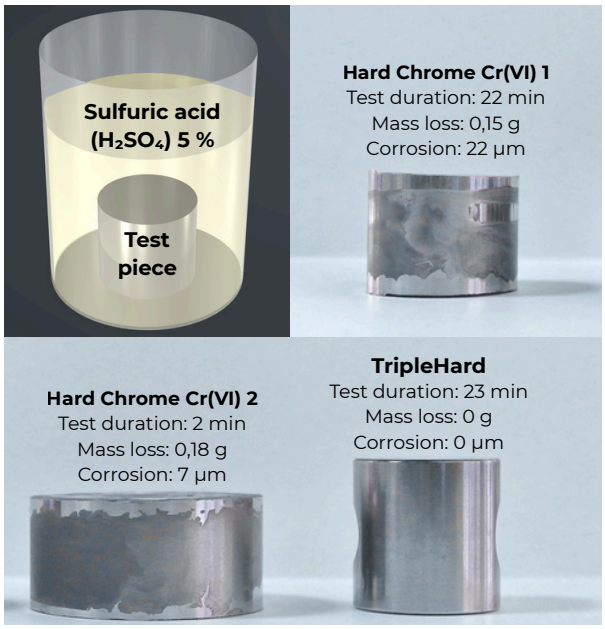
TripleHard® forms a hard (900–1,500 HV), uniform surface that resists sliding wear between the valve stem and guide. In sliding wear tests, a 20 µm TripleHard® layer withstood **35 MPa** contact pressure without measurable wear, outperforming conventional hard chrome and nitrated surfaces. The coating passed 180° bend and severe scratch tests with no detachment or cracking, and its low friction (**0.15–0.20 vs. ~0.25 for conventional coatings**) lightens valve movement and reduces guide wear.

In a customer field test, TripleHard® coated valves achieved up to **75% lower compressed air consumption**, enabling smaller actuators, energy savings and longer maintenance intervals.

TripleHard® vs. conventional hard chrome for engine valves

Feature	TripleHard®	Cr(VI) Hard Chrome
Hardness (HV)	1,000 - 1,500	800 - 1,000
Friction coefficient	0.15 - 0.2	0.30-0.35
CO_2 emissions	Low	High
Corrosion resistance	Excellent	Moderate
Temp. resistance (°C)	>500	350 - 400
Coating thickness (µm)	5 - 60	5 - 200

TripleHard® technology extends engine valve life and reliability in heavy-duty diesel and industrial engines, keeping valves in service longer and maintenance costs under control – delivering **durability, performance and sustainability without compromise.**



Heat and corrosion resistance

TripleHard® maintains its structure and hardness at extreme temperatures, withstanding **>500 °C** without softening, whereas conventional hard chrome starts to lose strength around **400 °C**. This is critical for exhaust valves exposed to constant high thermal loads and rapid cycling.

In a sulfuric acid test (**5% H_2SO_4, 100 °C**), TripleHard® showed no visible mass loss over the full test time, while Cr(VI) hard chrome suffered significant attack within minutes, meaning TripleHard® protects valves from aggressive condensates and combustion residues over long service intervals.

Repairability and lifecycle cost

TripleHard® coated valves can be refurbished instead of scrapped. The coating can be polished off, the surface re-prepared and re-coated without changing base material dimensions or mechanical properties, even after exposure to very aggressive environments. This enables full component rebuilds, reducing downtime, waste and total lifecycle cost while improving overall engine reliability.

HOW TO INTEGRATE TRIPLEHARD INTO YOUR COATING PRODUCTION

Drop-In Retrofit for Existing Lines

TripleHard® can be integrated into existing engine valve coating lines as a drop-in replacement for conventional hard chrome. The process uses a duplex nickel-plus-chrome structure and operates with standard electroplating infrastructure. Existing tanks, power supplies, and racking systems remain largely usable, with targeted adjustments where needed.

Minimal equipment changes and cost efficiency

Current Cr(VI) plating lines can be retrofitted with only minor upgrades. The key steps include:

- Replacing the Cr(VI) bath with Savroc's trivalent chrome chemistry
- Adding a nickel underlayer plating stage
- Adapting existing process parameters using Savroc's validated settings

Retrofitting existing lines for TripleHard® is often more cost-effective than upgrading Cr(VI)-based systems to meet tightening regulatory standards. Facilities can avoid the high costs associated with fume extraction upgrades, waste handling infrastructure, and permitting adjustments required for continued Cr(VI) use.

Environmental and compliance benefits

TripleHard®'s trivalent chemistry is hexavalent-free, boric acid-free, and fully REACH-compliant. This greatly simplifies:

- Wastewater treatment
- Fume extraction
- Workplace safety and audit processes

Switching to TripleHard® helps facilities lower their environmental footprint and meet regulatory demands.

Phased transition approach

Customers can begin by coating a specific valve series using TripleHard® while continuing other products on their legacy lines. Over time, more production can be shifted over. New lines can also be built from scratch using the TripleHard® platform. This flexible rollout strategy helps manage operational risk, training, and capacity planning.

Easy to start

Savroc offers a no-pilot startup path: customers can begin direct production using pre-qualified bath chemistry and operating parameters. For facilities seeking added validation, pilot-scale trials can also be arranged at Savroc's site or the customer's plant. In both cases, Savroc provides full technical support and operator training to ensure a smooth ramp-up.

Seamless downstream processing

After plating, TripleHard®-coated valves are processed using the same finishing steps as conventional chrome:

- Grinding
- Lapping
- Polishing

The coating supports tight dimensional tolerances, ensuring consistent valve fit in guides and seats. Re-grinding or polishing during maintenance is also possible without coating damage, thanks to strong adhesion and repairability.

Retrofit your existing line >>> **License, training & audit** >>> **Ramp-up & Cr(VI) phase-out**

PROVEN PERFORMANCE. READY TO DEPLOY.

TripleHard® is a trivalent Ni+Cr coating that pairs hard-chrome-class performance with modern EHS compliance. Built for engine valves in demanding conditions.

Spec highlights

- **Coating:** Nickel underlayer + Cr(III) top layer
- **Hardness:** 1,000-1,500 HV
- **Surface roughness:** < 0.2 µm
- **Heat resistance:** >500 °C, no softening
- **Acid resistance:** 5% H_2SO_4 at 100 °C – no mass loss
- **Friction & wear:** µ = 0.15–0.20; 20 µm at 35 MPa, no wear
- **Repairability:** Strip + re-coat; full refurbishment

Test methods & compliance

ISO 9227 (NSS)

ISO 10289 (corrosion evaluation)

ISO 4287 (Surface roughness Ra)

Cr(VI)-free & REACH-compliant

Supports EU substitution expectations

Improves EHS: Lower exposure, simpler ventilation & waste handling, reduced audit risk

Request trials · Book a corrosion/wear evaluation · Get detailed test reports

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